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United States Department of the Interior
Fish and Wildlife Service

Fishery Leaflet 63

Chicago 54, Ill.

Re-issued June 1944

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INVESTIGATIONS

The Body Oil From Menhaden (Brevoortia tyrannus)[1]

A. Low Temperature Crystallization of Glycerides
B. Some of the 18 and 20 Carbon Atom Acids

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Introduction

The body oil of menhaden *(Brevoortia tyrannus)* has long been available as an industrial product. Stingley (15) has published information on the commercial availability of fatty acid concentrates from fish oils including menhaden.

The study of menhaden fish oil was undertaken with the belief that fundamental knowledge of the chemical composition would make it a more valuable intermediate in the manufacture of chemical products.

Embree (6) has reported that molecular distillation of menhaden oil yields glycerides of widely separated iodine numbers. Riemenschneider, Swift, and Sando (13) have shown that cottonseed oil glycerides can be separated by low temperature crystallization from acetone. Menhaden oil was separated into three fractions in this study: 12.4 percent with an iodine number of 92.9, 75.0 percent with an iodine number of 179.0, and 12.6 percent with an iodine number of 264.2. The last fraction remained in solution at the temperature of dry ice. The attempted use of less acetone at higher temperatures failed to give a soluble fraction with an iodine number above 198.4.

The precipitate obtained from winterizing crude menhaden oil was crystallized several times from acetone to give a crystalline solid. Methanolysis and fractional distillation indicated 19.6 percent methyl myristate, 62.0 percent methyl palmitate, 17.6 percent methyl stearate and 0.8 percent of an ester of higher molecular weight.

The unsaturated acids with eighteen carbon atoms obtained from menhaden oil were found to give dihydroxystearic acids from which 9, 10-dihydroxystearic acid was isolated. Evidence was found also for an 11, 12-dihydrostearic acid. Bromination of concentrates with high iodine numbers gave octabromostearic acids. The eighteen carbon fraction contains chiefly △ 9, 10-octadecenoic acid with some △ 11, 12-octadecenoic and octadecatetrenoic acid.

The twenty carbon unsaturated acids produced 11, 12-dihydroxy eicosanoic acid and decabromoeicosanoic acid. This fraction is composed mainly of △ 11, 12-eicosenoic and eicosapentenoic acids.

Experimental

Saponification equivalents were determined by a modification of the method of Chargoff (5). A modification of the mercuric acetate catalyzed Wij's method described by Hoffman and Green (9) was used for the determination of the iodine number.

A. Low Temperature Crystallization of Glycerides

Saturated Glycerides. Crude menhaden oil after standing at 15° C. for several days was filtered by suction to remove as much of the adhering oil from the precipitate as possible. A sample of crude oil weighing 809 g. deposited 81 g. of paste with an iodine number of 139. A commercial sample of similar material (supplied by Menhaden Fish Products Company of Baltimore, Md.) that had been filter pressed at 5° C. had an iodine number of 136.

The paste was crystallized several times from acetone in the usual manner and the white crystals, having an iodine number of 5.9 and saponification equivalent of 268, melted at 53-54° C.

Alcoholysis of 120 g. of glycerides gave methyl esters that were used for fractional distillation. The fractions obtained and their properties are listed in Table 1. Assuming that each fraction contained two esters, it has been calculated that the composition was 19.6 percent methyl myristate, 62.0 percent methyl palmitate, 17.6 percent methyl stearate and 0.8 percent methyl arachidate. Pure myristic, palmitic and stearic acids were obtained from fractions 1, 7, and 11 respectively.

TABLE 1
Fractionation of the Methyl Esters From the Saturated Glycerides

Fraction	Weight	B. pt. at 8 mm.	Saponification Equivalent
	gms.	*°C.*	
1	10.29	143-155	242
2	6.40	145-150	253
3	5.54	150-155	254
4	4.78	155-157	255
5	3.08	157	255
6	14.48	157-162	272
7	36.76	162-165	278
8	12.79	165	274
9	2.81	165-170	280
10	3.36	170-179	289
11	5.61	179-183	300
12	3.64	183-184	298
13	1.76	Holdup	313
14	5.32	Residue	Dark Red

Crystallization of Destearinated Menhaden Oil. Eight hundred g. of destearinated oil obtained from Fish Products Company, of Lewes, Delaware, was dissolved in the required volume of acetone (see Table 2). After 48 hours at —15° C., the mixture was filtered by suction through a previously cooled funnel and paper. The two solutions were allowed to reach room temperature, dried over anhydrous calcium chloride and the acetone was distilled in an

[1] Taken in part from a thesis submitted to the University of Maryland in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

[2] This section was presented before the Division of Agricultural and Food Chemistry of the American Chemical Society Meeting in Atlantic City, N. J., September, 1941.

inert atmosphere. The last traces were removed at the water pump.

In one instance, when 10 ml. of acetone was used per g. of oil, the filtrate was cooled to —60°C. with solid carbon dioxide. The mixture was held at this temperature for one hour, then the supernatant liquors were removed with a filter stick.

TABLE 2

Analysis of Fraction Obtained by Crystallization of Menhaden Oil

Fraction	Temperature	Acetone per g. oil	Yield %	Iodine number	Saponification equivalent
	° C.	ml.			
Original oil	....	....	....	181.3	300
A. Precipitate	—15	2.5	23.6	135.3	277
Filtrate	....	....	76.4	198.4	308
B. Precipitate	—15	5.0	16.0	107.7	295
Filtrate	....	....	84.0	195.3	301
C. Precipitate	—15	10.0	12.4	92.9	290
Filtrate recooled:					
Precipitate	—60	....	75.0	179.0	298
Filtrate	—60	....	12.6	264.2	305
Saturated glycerides	....	....	2.0 [1]	5.9	268

[1] From crude menhaden oil.

B. Some of the 18 and 20 Carbon Acids (W.H.B.)

Separation of the Unsaturated Acids With 18 Carbon Atoms. Distillation of the methyl esters obtained from 2 kg. of unsaturated acids (lead soap soluble in ethanol) yielded 220 g. of material boiling at 160-165° C. at 2 mm. The saponification equivalent was 294. Redistillation of some of the intermediate fractions gave a further 206 g. yield having a saponification equivalent of 293 and an iodine number of 123. Methyl oleate requires a saponification equivalent of 296 and an iodine number of 86.0; methyl linoleate requires a saponification equivalent of 294 and an iodine number of 173.

Octadecenoic Acids. A 200 g. sample of methyl esters (sap. equiv. 293 and I.V. 123) was dissolved in 2 liters of acetone. The mixture was cooled by adding solid carbon dioxide until an excess was present. A filter stick was used with vacuum to remove 1 l.(iter), of filtrate that contained 36.0 g. of esters having an iodine number of 181.

Acetone (500 ml.) was added to the residue that was cooled and filtered as before. From this filtrate there was obtained 31.0 g. of esters having an iodine number of 166.

The process was repeated by adding 500 ml. of acetone to the residue and by cooling and filtering as before. The filtrate yielded 19.4 g. of esters having an iodine number of 153. From the precipitate was obtained 112.4 g. having an iodine number of 89.5. Methyl oleate requires an iodine number of 86.0.

The acid was liberated by saponification from the ester of iodine number 89.5 and used for the preparation of p-phenylphenacyl ester by the method of Drake and Bronitsky (7). The compound isolated melted at 58-59° C.; authentic p-penylphenacyl oleate melted at 61° C. A mixture of the two substances melted at 60-61° C.

A 50 g. sample of esters (iodine value 89.5) was saponified and the acids were hydroxylated with alkaline permanganate by the method of Lapworth and Mottram (12). After extraction with petroleum ether, the product was fractionated from 95 percent ethanol. The less soluble fraction consisted of 32 g. of crystals melting at 128.5° C. An authentic specimen of 9, 10-dihydroxystearic acid melted at 131° C. A mixture of the two melted at 130.5° C.

Analysis—Calculated for $C_{18}H_{36}O_4$: Sap. equiv., 316.

Found: Sap. equiv., 316.

The more soluble fraction weighing 2.8 g. melted at 115-116° C.

Analysis—Calculated for $C_{18}H_{36}O_4$: Sap. equiv., 316.

Found: Sap. equiv., 316.

Periodate Cleavage of the Higher Melting Substance. Using a combination of methods suggested by King (11) and Hsing and Chang (10) the acid (m.p. 128.5) was split and the fragments identified as semicarbazones. Potassium periodate (1 g.) in 30 ml. of normal sulfuric acid at 20°C. was added to a solution of 1 g. of the dihydroxystearic acid in 65 ml. of 95 percent ethanol at 40° C. After standing 15 minutes, the mixture was cooled to 15° C., diluted with water to dissolve precipitated salts and extracted with ether. The ether was removed under reduced pressure and 0.7 g. semi-carbazide hydrochloride and 1.5 g. sodium acetate in aqueous alcohol were added. The precipitated semi-carbazones were filtered and extracted with 1 percent sodium hydroxide.

The alkaline filtrate was acidified with 2 percent hydrochloric acid and the precipitate (0.45 g.) when crystallized from aqueous alcohol melted at 160° C. Scanlon and Swern (14) reported a melting point of 161-2° C. for azelaic acid half-aldehyde semicarbazone.

Analysis—Calculated for $C_{10}H_{19}O_3N_3$: C, 52.4%; H, 8.3%.

Found: C, 52.8%; H, 8.2%.

The alkali insoluble portion weighing 0.25 g. was crystallized from aqueous alcohol. The melting point and mixed melting point with authentic nonanal semicarbazone was 99° C.

Analysis—Calculated for $C_{10}H_{21}ON_3$: C, 60.3%; H, 10.6%.

Found: C, 60.3%; H, 10.9%.

Periodate Cleavage of the Lower Melting Substance. One g. of acid (m.p. 115-116° C.) was oxidized with potassium periodate in the same manner as described above. The semicarbazones were prepared and separated on the basis of their solubility in alkali.

The alkali soluble portion, after acidification, was fractionated from aqueous alcohol. A portion weighing 0.15 g. melted at 155° C. Mixed m.p. with the semicarbazone of azelaic acid half-aldehyde was 145° C.

Analysis—Calculated for $C_{12}H_{23}O_3N_3$: C, 56.0%; H, 8.95%.

Found: C, 55.6%; H, 9.17%.

The mother liquors yielded 0.15 g. of material, m.p. 149° C.

Analysis—Calculated for $C_{10}H_{19}O_3N_3$: C, 52.4%; H, 8.3%.

Found: C, 53.9%; H, 8.4%.

The alkali insoluble portion on fractionation from aqueous ethanol yielded 0.10 g. m.p. and mixed m.p. with authentic nonanal semicarbazone, 99° C.

Analysis—Calculated for $C_{10}H_{21}ON_3$: C, 60.3%; H, 10.6%.
Found: C, 59.9%; H, 10.4%.

From the mother liquors were obtained 0.05 g., m.p. 83° C.

Analysis—Calculated for $C_9H_{19}ON_3$: C, 58.4%; H, 10.3%.
Found: C, 58.6%; H, 10.1%.

The m.p. recorded for octanal semicarbazone is 98° C.

Octadecatetrenoic Acid. The esters (iodine number 181) obtained in the first filtrate from the acetone crystallization of the 18 carbon acid esters were saponified and the liberated acids brominated. The esters (35.0 g.) were saponified by means of a hot solution containing 9 g. of potassium hydroxide in 7 ml. of water and 30 ml. of alcohol. After complete saponification the mixture was acidified, cooled, and the acids extracted with ether. The ether solution was washed three times with distilled water, the volume was brought to 500 ml. by the addition of ether and dried over anhydrous sodium sulfate. This solution was passed through a column (about 75 x 25 mm.) of activated alumina (Grade A, mesh 80 to 200 from the Aluminum Ore Company of America) to remove colored material.

The ether solution that had passed through the alumina was cooled to —5° C. in a 3-necked flask and surrounded by chopped ice. Bromine was added dropwise with mechanical stirring. Stirring was continued for an hour after an excess of bromine was indicated by the color of the solution. Amylene added to the mixture reacted with the excess bromine. The precipitate was filtered and carefully washed 4 times with ether. No solvent was found suitable for the recrystallization of this material. The yield was 1.0 g., m.p. 230° C.

Analysis—Calculated for $C_{18}H_{28}O_2Br_8$: Br, 69.8%.
Found: Br, 69.6%.

A second crop of 1.0 g. was obtained from the ethereal mother liquors by evaporating to a small volume and adding petroleum ether.

Separation of the Unsaturated Acids with 20 Carbon Atoms. The same distillation which provided the 18 carbon fraction yielded 290 g. of esters boiling 175-180° C. at 2 mm. having saponification equivalent of 317 and an iodine value of 228. The methyl ester of a 20 carbon acid with 3 double bonds requires a saponification equivalent of 320 and an iodine value of 235.

Eicosenoic Acid. A 75 g. sample of the mixed esters of 20 carbon acids dissolved in 750 ml. of acetone was cooled by adding solid carbon dioxide in excess and was allowed to stand for 1 hour. The dried precipitate (liquid at room temperature) weighed 28.9 g. and had an iodine number of 136.7. The acids liberated by saponification of 26.5 g. of esters, were converted to their lithium salts and crystallized twice from 80 percent aqueous ethanol. The liberated acid (4.5 g.) had an iodine number of 87.4 (theoretical for eicosenoic acid is 81.9.

A sample (4.3 g.) of the eicosenoic acid was converted to dihydroxyeicosanoic acid by alkaline permanganate according to the method of Lapworth and Mottram (12). The crude product after extraction with petroleum ether (3.9 g.) was crystallized from 95 percent ethanol m.p. 115.5-116° C.

Analysis—Calculated for $C_{20}H_{40}O_4$: Sap. equiv., 344.
Found: Sap. equiv., 341.

Periodate Cleavage of the Dihydroxyeicosanoic Acid. A 0.5 g. sample of the dihydroxyeicosanoic acid was oxidized with potassium periodate using half the quantities used before. The semicarbazones were prepared and separated with alkali.

The alkaline extract, after acidification and washing, was crystallized 3 times from aqueous ethanol. The crystals (75 mg.) melted at 156° C. and showed no depression of the melting point when mixed with the similar semicarbazone from the lower melting dihydroxystearic acid.

Analysis—Calculated for $C_{12}H_{23}O_3N_3$: C, 56.0%; H, 8.95%.
Found: C, 55.7%; H, 8.91%.

The alkali insoluble semicarbazone was washed with water and crystallized from aqueous ethanol. The crystals weighed 0.12 g., m.p. and mixed m.p. with authentic nonanal semicarbazone 99° C.

Analysis—Calculated for $C_{10}H_{21}ON_3$: C, 60.3%; H, 10.6%.
Found: C, 59.7%; H, 10.5%.

Eicosapentenoic Acid. The 20 carbon acids from 13.4 g. of mixed esters were brominated in ether. The ether insoluble portion was extracted with 30 ml. quantities of hot solvent, first with toluene, then four times with benzene. The resulting tan powder, m.p. 258-265° C., after darkening at 230° C., weighed 1.42 g.

Analysis—Calculated for $C_{20}H_{30}O_2Br_{10}$: Br, 72.6%.
Found: Br, 71.0%.

The mother liquors after concentration and addition of petroleum ether yielded crystals which were crystallized from ether-petroleum ether mixtures. This substance weighed 0.43 g., m.p. 150-155°C.

Analysis—Calculated for $C_{20}H_{30}O_2Br_{10}$: Br, 72.6%.
Found: Br, 71.0%.

Discussion

The saturated glycerides recrystallized from acetone yielded myristic acid, palmitic acid, stearic acid, and one with higher molecular weight. While palmitic acid was present in the greatest quantity, the proportion was not large enough to indicate the existence of tripalmitin.

Cooling menhaden oil in acetone (10 ml. of acetone per g. of oil) to —15° C. precipitated 12.4 percent of the oil having an iodine number of 92.9. The filtrate from the above when further cooled to —60° C. with carbon dioxide ice precipitated 75.0 percent of the glycerides with an iodine number of 179.0. The fil-

trate still contained 12.6 percent of the glycerides and these had an iodine number of 264.2. The iodine numbers of these fractions suggest possible uses to which they might be put.

An attempt was made, by reducing the volume of acetone used and by using a higher temperature, to concentrate the highly unsaturated glycerides in the filtrate. At —15° C., using 2.5 ml. of acetone per g. of oil, the filtrate contained over 76 percent of the oil and this had an iodine number of 198.

The separation of unsaturated fatty acids in pure form is a long process. The dihydroxy derivatives prepared from mono-olefinic acids are crystalline and after purification can be split either by lead tetraacetate or periodic acid into aldehydes that locate the original position of the double bond. By this procedure, it has been demonstrated that the 18 carbon acids that represent 25 to 31 percent (2) of the total fatty acids are mostly △ 9, 10-octadecenoic acid.

Fractional crystallization of the mixed dihydroxy derivatives produced a mixture melting at 115.5-116° C. Periodate oxidation of this mixture gave semicarbazones indicating the following fragments:

1. $CH_3(CH_2)_7CH=$
2. A mixture similar to 1 but with fewer carbons
3. $=CH(CH_2)_8COOH$
4. A mixture similar to 3 but with fewer carbons.

It appears likely that the mixture contains both △ 9, 10, and △ 11, 12-octadecenoic acids. The △ 11, 12-octadecenoic acid (vaccenic acid) has been reported by Bertram in beef and butter fats and by Armstrong and Hilditch (1) in whale oil.

Bromination of the 18 carbon acids has yielded solid derivatives with 8 Br only. A similar octadecatetrenoic acid has been isolated from Japanese sardine oil. Toyama and Tsuchiya (16) obtained an octabromostearic acid that melted at 220° C. Brown and Beal (17) also reported the isolation of the ester of octadecatetrenoic acid from menhaden oil.

The methyl esters of the 18 carbon acids that were obtained by fractional distillation had an iodine number of 123. It can be calculated from theoretical iodine numbers that this fraction is composed of 86 percent octadecenoic and 14 percent octadecatetrenoic acids.

The dihydroxyeicosanoic acid melted at 115.5-116° C. but was probably not homogeneous. Green, Hilditch and Stainsby (8) obtained an 11, 12-dihydroxyeicosanoic acid from a seed wax that melted at 130.5° C. The product obtained here was shown to be mainly 11, 12-dihydroxyeicosanoic acid by periodate cleavage to the following two fragments:

1. $CH_3(CH_2)_7CH=$
2. $=CH(CH_2)_8COOH$.

The isolation of decabromoeicosanoic acids as the only solid bromo derivatives indicates the presence of at least one 20 carbon acid with 5 double bonds. It does not rule out the possibility of other acids in small amounts. Toyama and Tsuchiya (16) have reported a decabromoeicosanoic acid from sardine oil melting around 240° C.

The mixed 20 carbon acid esters obtained from the distillation had an iodine number of 228. Calculations based on theoretical iodine numbers show that this fraction contains 54 percent eiscosenoic and 46 percent eicosapentenoic acids.

Summary

A saturated glyceride from crude menhaden oil contained myristic, palmitic, stearic, and a small quantity of higher molecular weight acids.

The glycerides of destearinated menhaden oil have been fractionated by crystallization from acetone at low temperatures.

Distillation of methyl esters has given in the distillate △ 9, 10 and △ 11, 12-octadecenoic acids, an octadecatetrenoic acid, △ 11, 12-eicosenoic acid, and an eicosapentenoic acid.

Acknowledgment

The authors wish to express their indebtedness to the staff of the Chemistry Department of the University of Maryland and to the staff of the Technological Laboratory of the Fish and Wildlife Service for their assistance, particularly to Dr. Hugh J. Creech of the Faculty of the University of Maryland.

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[Reprinted from OIL & SOAP, June, 1943, Issue, Vol. XX, No. 6, Pages 101-104]

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Fishery Leaflet 64

Washington 25, D. C. Reissued January 1950

CONSTRUCTION AND OPERATION OF LOBSTER FISHING GEAR

By Frank E. Firth*
Illustrated by Boris O. Knake**

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Hoop-net

The early gear used to catch lobsters on the northeast coast of the United States was the hoop-net. This was made by fastening webbing to a hoop about 36 inches in diameter so as to form a bag approximately 18 inches deep. A rigid cross bridle was fixed to the hoop, and at the center of the bridle the hauling line was fastened. The bait was suspended from this same point.

As the lobsters were free to leave, the net had to be tended constantly. To lessen the amount of attention required, the fishermen soon devised traps that allowed the lobsters to enter but prevented their escape.

Being home made, these traps or pots were fashioned from many different materials and varied greatly in both size and design. However, the lobstermen have gradually settled on two types of pots as most satisfactory, the semicylindrical, or "half-round," and the rectangular. The construction of these is now more or less standardized except for minor variations in the size of the trap and the number of entrances. In certain fishing localities small lumber mills furnish materials cut to the lobstermen's specifications. Thoroughly seasoned oak, spruce, and hemlock are favored for lobster pot construction.

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Half-Round Lobster Pot

The semicylindrical lobster pot found its first extensive use in Maine and, although made with varying dimensions and construction, is still the most popular trap in that State as well as in some other areas along the coast. Figures 1 and 2 illustrate the construction of a typical trap.

The base is about 32" long by 27" wide; the height is about 18", all outside measurements. Each pot requires three bows. The bow is made from a board 47" long x 1-1/8" wide x 1/2" thick. Each end of this board is turned or whittled to form a cylindrical pin 2" long x 1/2" diameter. Three sills are made from boards 27" long x 1-1/2" wide x 1" thick. Two holes, 1/2" in diameter, are drilled through each sill, centered 2-1/2" from each end.

The board for the bow is steamed and bent to form a U, and the cylindrical ends are inserted into the holes in the sill so that the pins project 1" beyond the sill.

To complete the frame of the pot, two runners are made from boards 32" long x 1-1/2" wide x 1" thick. Each runner is drilled with three holes 1/2" in diameter to receive the projecting pins of the bows. Two of the holes are centered 3/4" from each end of the runner; the third is centered 15-1/4" from one end. The three bow and sill sets are then fastened to the runners by having each pair of projecting pins of the bows slipped into the corresponding holes in the two runners. Galvanized nails are driven through the sills and runners into the pins of the bows in order to secure the joints.

Common building laths, usually about 1-1/8" wide x 3/8" thick, are nailed to the sills, bows, and ends, except where the door and the entrance funnels are to be installed. The laths are spaced approximately the width of a lath apart. Some States require that the first side lath be at least 1-1/2" above the floor of the trap to aid the escape of undersized lobsters. The door to permit access into the pot is made of three laths fastened to three cleats of the correct curvature. Hinges formed from leather or rubber straps hold the door in a longitudinal position across the pot near the top of the bows.

The bows now divide the trap into two sections. The shorter section is called the chamber. The lobster, seeking the bait, enters the chamber section first, and then crawls into the larger section, or parlor, where it is trapped.

The chamber, or shorter section, is usually provided with an entrance on each side. The openings start about $2\frac{1}{2}$ inches above the floor of the pot, and are about 8" high x 13" long. Each is provided with netting to form a funnel about 7" deep which ends in a ring 4" to 6" in diameter. Two or three brace lines tied between the two rings draw the netting taut to form two rigid funnels. The inner funnel or "long head" is then lashed or nailed to the middle bow and tied into position. The bait hook or bait bag cleat is also fastened to the

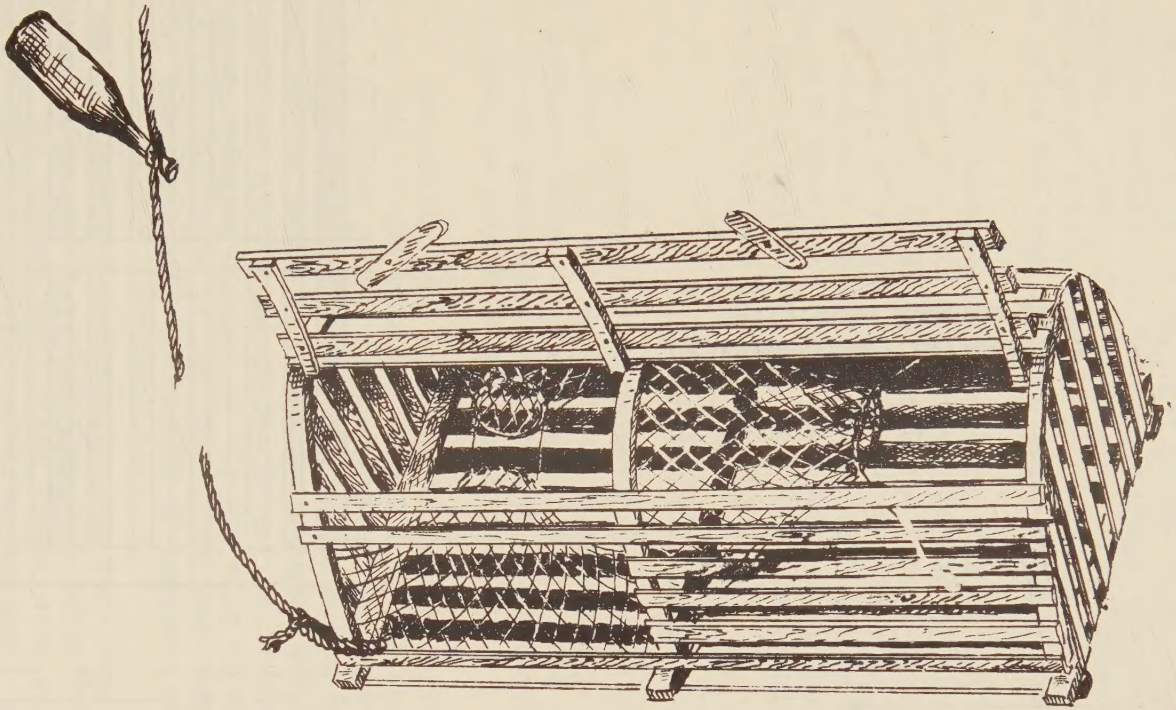


Figure 1

Half-round Lobster Pot

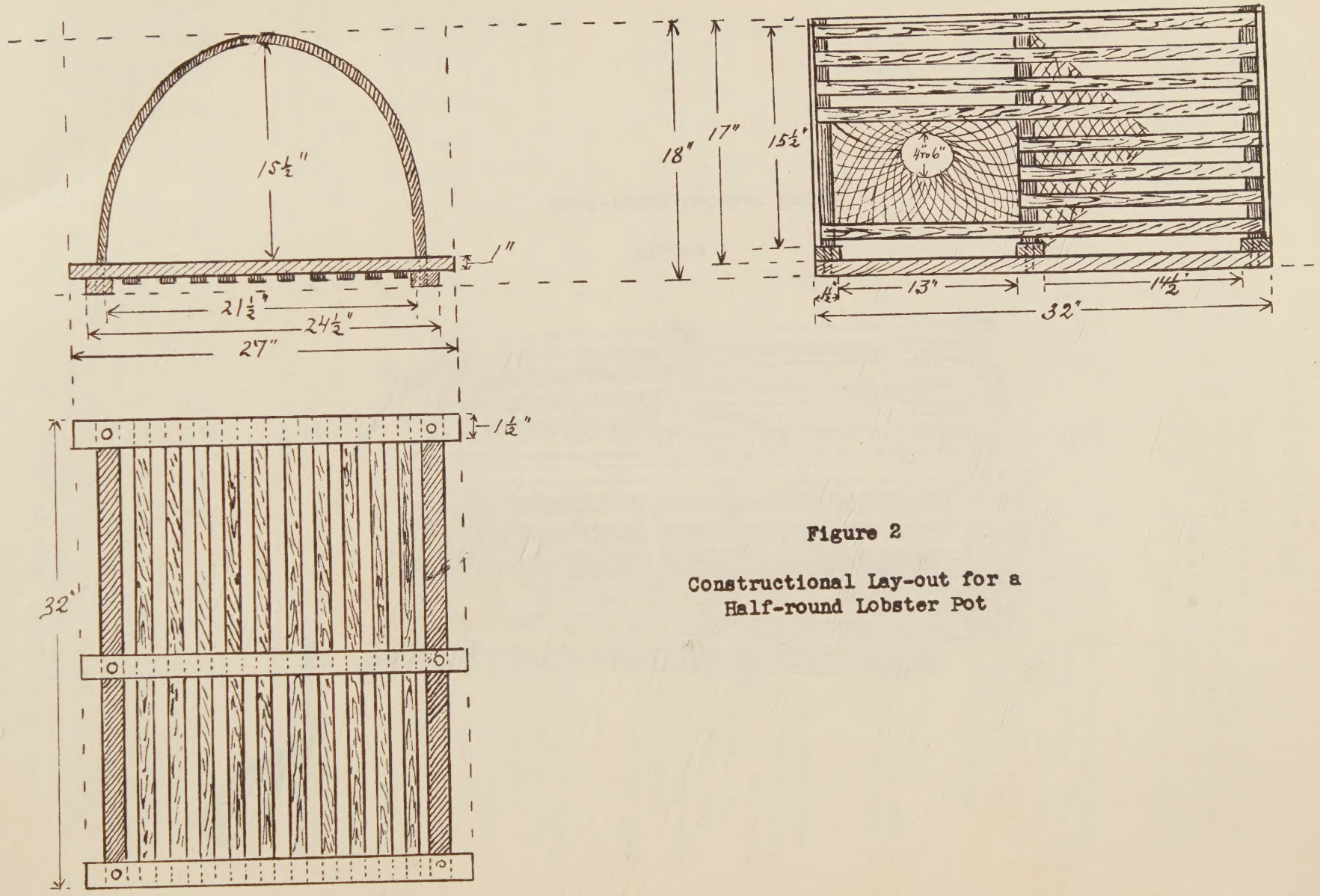


Figure 2

Constructional Lay-out for a Half-round Lobster Pot

center of the middle bow. The buoyline is attached at a lower corner of the chamber end.

The completed trap is weighted with two to four common building bricks which are distributed evenly on the bottom laths so as to maintain the balance of the trap. Laths are nailed around the bricks to hold them in place, or else they are fastened with wire or cord. When the trap is new, and at the beginning of each season thereafter, extra ballast will be needed until the pot becomes thoroughly water-soaked. Large, flat stones are often used for this purpose; they are lashed either inside or outside the pot and are removed after the trap has been under water a few days.

The dimensions and construction of the half-round pots vary considerably. The pots may be from 28" to 48" long. In some localities, especially in Rhode Island and Long Island, the outer heads are often made of wooden laths wired together to form a funnel. A few pots even have the inside funnel replaced by a vertical, self-closing, lath door that traps the lobsters in the parlor. In other places, particularly in Maine, the bows are fashioned from spruce saplings, smoothed and bent into shape.

Rectangular Lobster Pot

The rectangular or "square" pot is of more recent design than the half-round type and is gaining in popularity. The absence of curved surfaces makes the rectangular traps more rugged and easier to repair. These traps also stack better so that more can be carried in a small boat, or stored in a given space.

Originally, the rectangular pot had only one entrance; this was at the end of the trap and opened into the chamber, or shorter section. An inner funnel then separated the chamber from the parlor. However, seaweeds and other debris often caught on the buoy line and slid down to the lower corner of the chamber end, thus blocking the single entrance at the end of the trap. It is now the usual practice to build an entrance on each of the opposing sides of the chamber. With this construction it has been found that there is little chance that both entrances will be blocked by seaweeds or other obstructions.

The earliest rectangular pots were made of wooden dowel rods, 1/2" in diameter, which were fitted into holes drilled in a framework of boards. The runners were often fitted with steel shoes which took up most of the wear and also served as ballast. Many years of service could be obtained from one of these traps, but because of their greater cost and extra weight, relatively few could be fished by one man. Some of these dowel rod, rectangular traps are still used by a few of the older fishermen.

The present-day, rectangular lobster pots vary in the details of their construction and range from 30" to 42" in length. A typical pot is illustrated in figures 3 and 4. It is 32" long x 15-1/2" high; the width at the base is 26"; the width at the top is 22", all outside measurements.

In structure, the rectangular pot is similar to the half-round except that the three bow and sill sets are replaced by three frames made from straight boards. The sides of each frame are 1" x 1" boards about 15-1/2" long the ends of which have been turned or whittled to form cylindrical pins 1/2" in diameter. The pin at the upper end is 1" long; the lower pin is 2" long. The top and bottom sills for each frame are 22" and 26" long, respectively. These are made from stock 2" wide by 1" thick in which, approximately 1" from each end, holes are drilled to receive the dowels of the sides. Since the sills are unequal in length, the sides of the frame slope, and either the holes or the pins must be cut on an angle. After the dowels of the sides are slipped into the holes in the sills, the frame is complete, and the lower pins project about an inch beyond the lower sill. The protuding pins serve to fasten the frames to the runners.

Two boards 32" long, made from the same stock as the sills, are used for runners. Three holes for receiving the dowels are drilled into each board. Two of the holes are drilled about 1" from each end of the runner; the third hole 15" from one end. These holes should be bored either vertically, or at an angle depending on the construction of the pins.

The three frames are fastened to the runners by having each pair of projecting pins slipped into the corresponding holes in the two runners. Galvanized nails are then driven through the sills and runners into the pins in order to secure the joints. A third runner, without holes, is nailed to the bottom sills between the other two runners. Laths, 1-1/8" wide x 3/8" thick, are nailed about the width of a lath apart to the sills and uprights, except where openings are provided for the door and entrance funnels. These openings are fitted in the same way as for the half-round pot, and the trap is weighted correspondingly.

With proper care, three or four years of service can be expected from either type of trap. The cost of materials exclusive of funnels, buoy line, and buoy, is from two to three dollars.

Funnels

The entrance funnels or head webbings are nearly always knitted by the fishermen or their families. A special heading twine of two-ply, Manila or sisal fiber, 900- or 1200-foot size, is generally used when available. However, medium-laid cotton seine twine, 36 to 54 thread, also is finding wide application for this purpose. Jute twine of similar size also has been used with satisfactory results. The use of nylon twine is also becoming very popular, especially along the New Jersey coast.

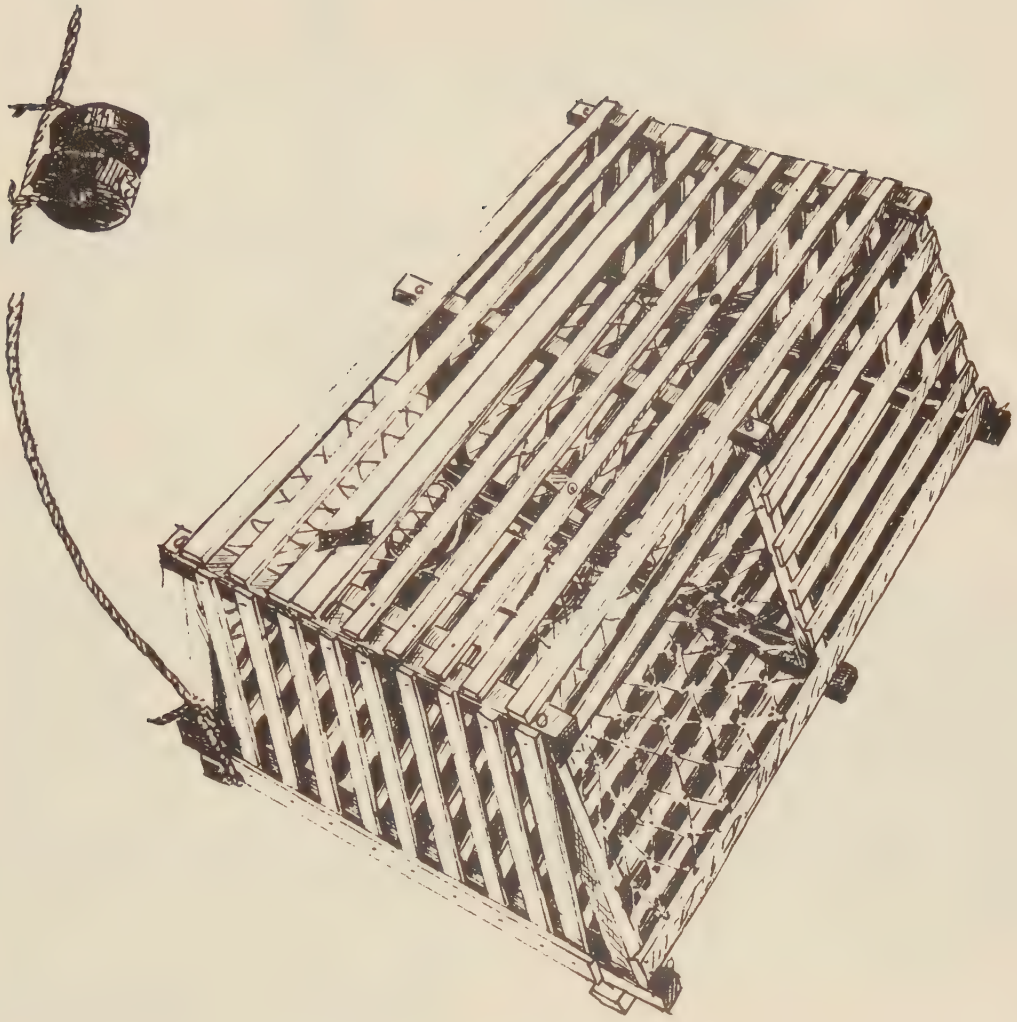


Figure 3

Rectangular Lobster Pot

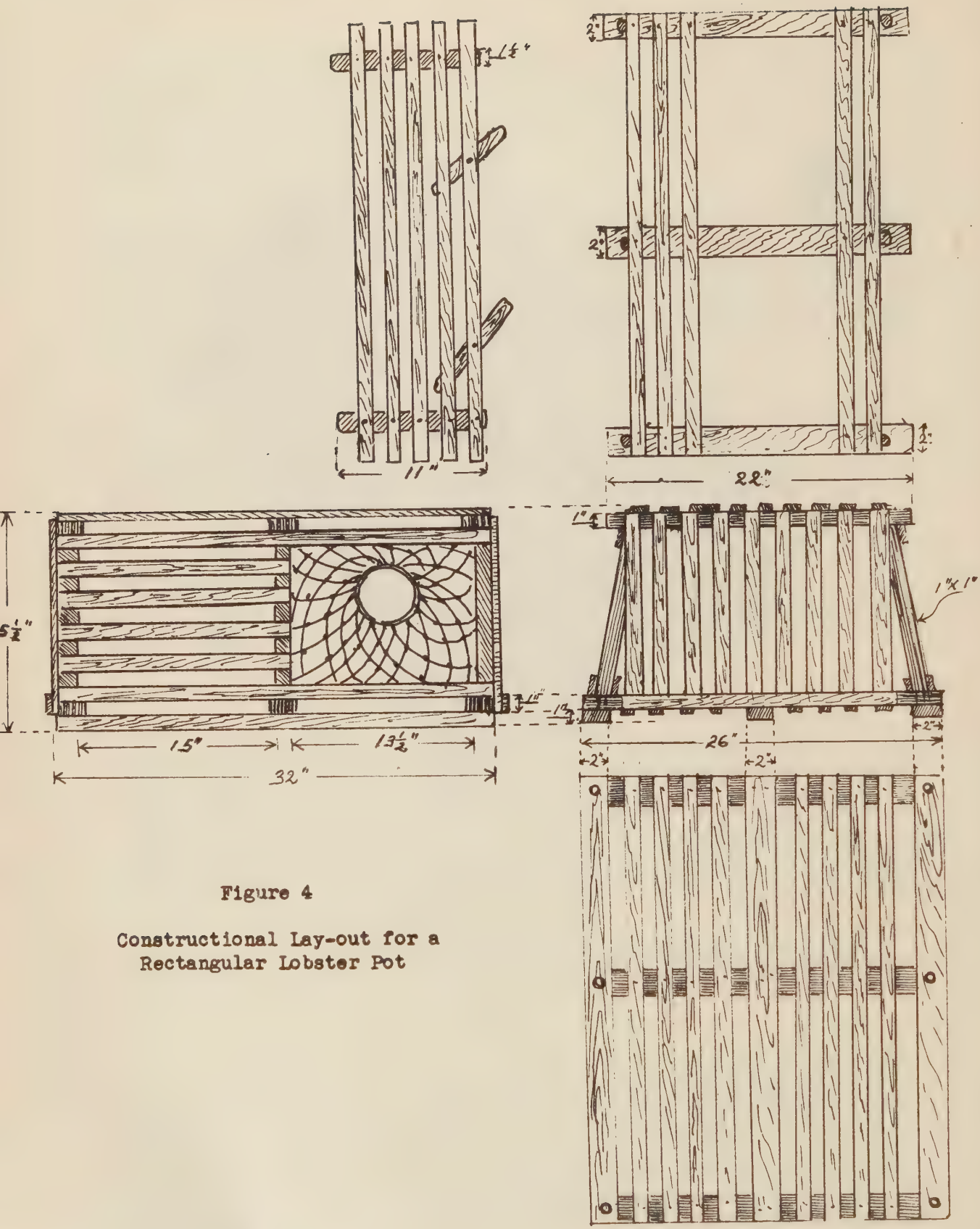


Figure 4

Constructional Lay-out for a
Rectangular Lobster Pot

Since the heads are in sea water throughout the lobster season, they need to be protected from fouling and rotting. The fishermen apply net preservatives such as copper oleate, copper naphthenate, coal tar, or water-gas tar to the knitted heads. These treatments materially lengthen the life of the netting.[2/] Sometimes pre-treated twine can be purchased.

Figures 5A, 6A, and 7A, respectively, show how the 3-1/4" mesh outer head, the 3" mesh outer head, and the 3" mesh inner head (stretched measure) are knitted in the shape of an inverted L. Figures 5B, 6B, and 7B show how the vertical leg is bent to fit the entrance ring. The dotted lines show the attachment of the vertical leg to the horizontal leg.

Figure 5B also illustrates how the ring is fastened to the completed 3-1/4" mesh webbing by "mending." The double lines show the method of knotting the twine to form the half-meshes that hold the ring. However, in Figure 6B the completed 3" mesh webbing is fastened to the ring by lacing. The lace is finished with one knot which corresponds to the point marked "end" in Figure 6A.

Metal or wooden rings, 4" to 6" in diameter, are used in the outer heads; however, as shown in Figure 7B, the ring in the parlor head is made from a 6 or 9-thread rope which is reeved through the meshes and tied to form a circle about 4" in diameter. The finished parlor head is nailed or laced to the middle bow or frame. Two brace lines, tied from the sides of the ring to the bow or frame at the end of the parlor, draw the netting in to form a taut funnel and at the same time stretch the ring to an ellipse about 5" or 6" long. This narrow, horizontal opening, illustrated in Figure 1, is flexible enough to permit easy entrance by the lobster, but makes its escape almost impossible.

Buoys

The buoy line or pot warp is the thread rope connecting the lobster pot on the ocean bottom with the buoy floating at the surface. This rope is also used in hoisting the trap. These buoy lines must be able to resist continuous immersion and severe abrasion; therefore, when hard fibers, such as Manila or sisal are available, they are generally used. The fishermen buy the rope in coils and cut off the desired lengths. The service life of the lines is increased by preservative treatments similar to those applied to head webbings. Cordage dealers often sell pretreated ropes prepared especially for lobstermen. However, many fishermen apply the preservative themselves.

2/ Further information is given in Fishery Leaflet 66, "Preservation and Care of Fish Nets," by F. E. Firth and C. B. Carlson. Obtainable from the Fish and Wildlife Service, Unites States Department of the Interior, Washington 25, D. C.

When the traps are fished singly, the lobstermen use cable-laid 6- or 9- thread (1/4" or 5/16" diameter) ropes. These are cut to be not less than a third longer than the depth at which the trap is set so as to allow sufficient stray in ordinary tides or currents. For stronger currents longer buoy lines are needed. A tightly sealed, empty bottle or a cork float is attached to the pot-warp about one fathom from the pot to raise the line off the bottom thus reducing abrasion and keeping the line from catching on submerged objects. This practice also eliminates the possibility of seaweed sliding down the pot-warp and blocking a side entrance.

Traps are also fished trawl-fashion, with as many as thirty, but usually about ten, traps fastened to a trawl by means of 9- or 12-thread rope gangings. These are about two fathoms long and spaced from five to ten fathoms apart. The trawl line is about 18- or 21-thread size and is usually buoyed at both ends, but where the current is strong, one end is buoyed and the other anchored.

Hardly any other piece of fishing equipment is made in so many designs and colors as the marker buoy. Practically every conceivable shape, from an efficient streamlined type to the modest "plug," in accordance with the fisherman's fancy, can be found in use along our eastern shore. Although there has been little attempt at standardization, buoys of streamline shape have been found to float better in a current and to accumulate fewer marine growths. Some of the more common styles are shown in Figure 8.

The many color combinations and patterns serve as means of identification. Some States require each fisherman to have his particular color scheme recorded on his license. Two, and often three colors, are used; the upper part of the buoy usually being bright red, orange, yellow, or white for greater visibility, while the lower part is usually black.

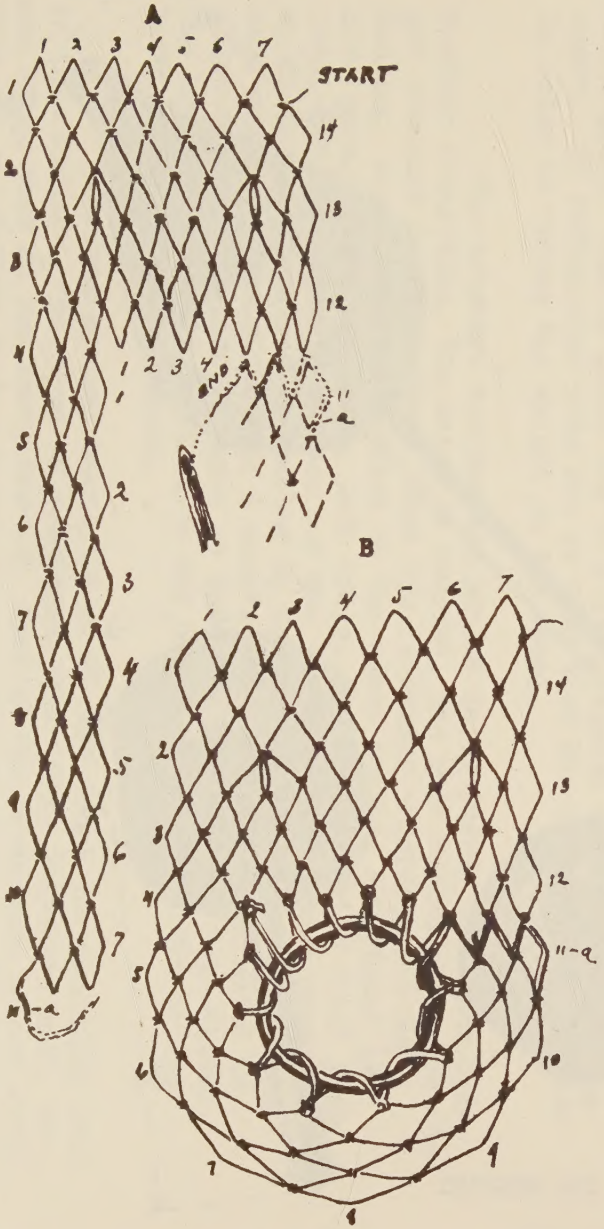
Thoroughly dried wood that has been seasoned as long as possible should be used for buoy construction, and pieces that check or crack should be discarded. Cedar is extensively employed, but good quality white pine serves nearly as well. For long service and maintenance of buoyancy, the cells of the wood should be completely sealed by frequent, thorough painting. A minimum buoyancy of five or six pounds is necessary for supporting the ordinary 6- or 9-thread line. This can be simply tested by immersing the buoy with a five-pound building brick attached. The depth at which the buoy floats determines its suitability.

Bait

The bait used in lobster traps generally consists of low-priced fresh or salted fish, unmarketable species, trimmings from nearby canneries, spoiled fish, or fish frames from which the fillets have

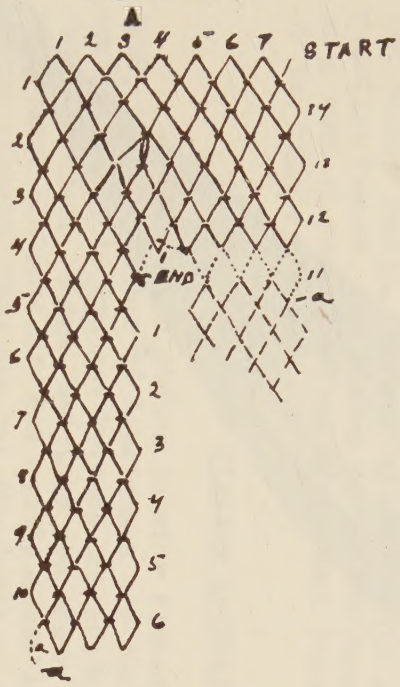
Method of Knitting Webbing used in Lobster Pot Head Construction

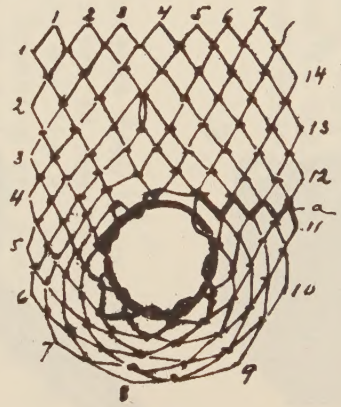
Figure 5



3 1/4" Mesh
Outer (chamber) Head

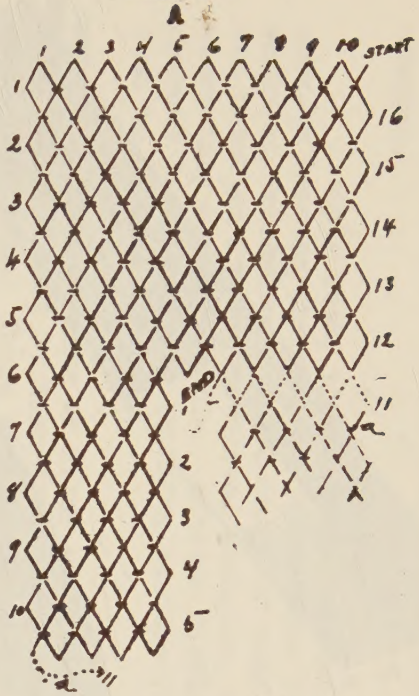
Figure 6

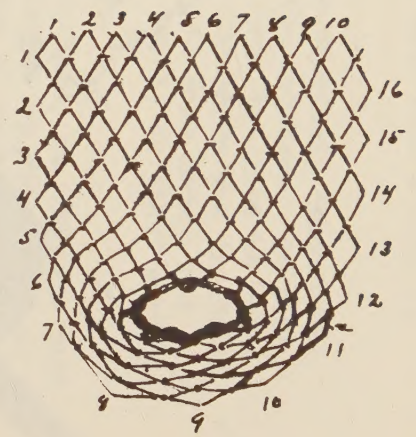




3" Mesh
Outer (chamber) Head

Figure 7

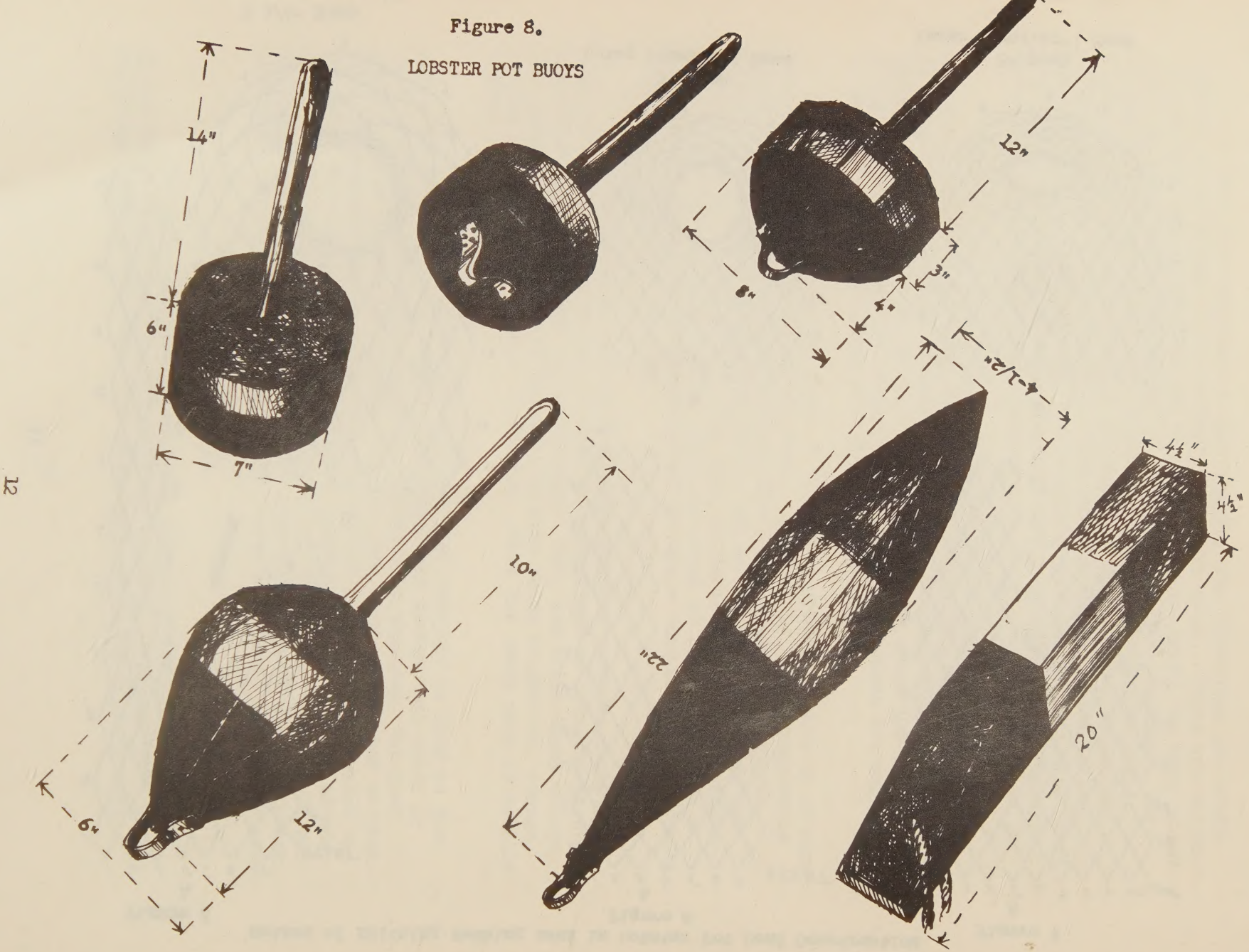




3" Mesh
Inner ("parlor") Head

Figure 8.

LOBSTER POT BUOYS



been removed. The cost of the bait is an important operating expense since an average of 1-1/2 pounds is required each time a trap is visited.

Oily fish, either fresh, salted, or partially decomposed, seem to possess the greatest attraction for the lobsters. Herring, mackerel, menhaden, and the heads of codfish lead the list as bait, but rosefish frames, alewives, sculpins, and flounders are in demand where they are obtainable. Lobster fishermen in some localities operate fish traps for catching cunners (sea perch) or other small fish to be used for bait.

When cunners or other small fish are used, or when the bait materials are soft or decomposed, they are chopped up and placed in small bait bags. These bags are knitted purses of one-inch mesh, stretched measure, and are treated with coal tar. They are suspended from the top of the middle bow so that they hang in the entrance of the parlor funnel. Larger or more solid pieces, such as cod heads and rosefish frames, are placed on a hook suspended in the same position or on a wood or metal, barbed spear that rises vertically from the base of the middle frame.

Fishing Methods

The United States lobster fishery extends from Maine to Maryland, but the number of lobstermen and their catch is smaller to the south. The pots are set between the shore line and the 30 fathom line, rarely deeper. Range bearings are taken for locating the gear. In most cases the pots are set singly about 10 to 25 fathoms apart; in a strong current, they are set the depth of the water apart to facilitate hauling. Where conditions are favorable, the pots are fished from trawl lines, usually about ten to a line, spaced five to ten fathoms apart. If rectangular pots are so used they are usually made smaller in order to reduce the weight on the trawl.

The pots are visited and hauled daily during the slack tide, weather permitting. The catch is removed, the bait replenished, and the pot returned to the bottom. When the fisherman completes his day's hauling, the lobsters are taken to the shore station and placed in live cars. These are large, lath traps, the tops of which float just level with the ocean's surface and are provided with a trap door through which the lobsters can be removed by means of a dip net. These live cars are large enough to hold a week's catch and are constructed to allow free circulation of water so that the lobsters are kept alive. The lobsters are held in the live car until enough have been accumulated for shipment to market.

Gasoline powered boats, 14 to 25 feet long, are generally used in this fishery. In areas of abundance, where many traps are used, two men often work on one boat; however, most of the lobstermen go out alone. Pots set in shallow water are sometimes tended in dories. If the distance required it, these are towed by a power boat.

Regulations

As State fishery authorities revise their regulations occasionally, it is advisable to write for the latest information before fishing is begun. Although State control does not usually extend beyond the three-mile limit, the lobsterman comes under State jurisdiction when he lands his catch.

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